

Human Health Criteria Development – General Rules
(based on criteria calculated for WA State using a 175 gram per day fish consumption rate)

This document provides a simplified discussion of calculations for human health criteria, based on how they were calculated for the State of Washington using a fish consumption rate (FCR) of 175 grams per day (gpd), and for the tribal water quality standards economic analysis. For relevant assumptions, this document provides (in blue font) a reference to the relevant cell or column in the calculation spreadsheet.

ASSUMPTIONS COMMON TO ALL CRITERIA

Fixed Assumptions

Human health criteria are calculated using certain common assumptions about the population consuming the water and/or fish, and the proportion of fish consumed from each trophic level. The following common assumptions are based on the most recent (2015) criteria development method, and will be considered fixed:

- Body weight (BW): 80 kilograms (kg) – found in cell C111 of the spreadsheet
- Drinking water intake (DWI): 2.4 liters per day (L/d) – found in cell C112 of the spreadsheet
- FCR for various aquatic trophic levels: the ratios below are fixed and need to be multiplied by the desired total FCR in kilograms per day (kg/d) to obtain the fish consumption for each trophic level in kg/d:
 - Trophic level 2 (TL2): 7.6/21.3 (approximately 35.7%) – found in cell E113 of the spreadsheet
 - Trophic level 3 (TL3): 8.6/21.3 (approximately 40.4%) – found in cell E114 of the spreadsheet
 - Trophic level 4 (TL4): 5.1/21.3 (approximately 23.9%) – found in cell E115 of the spreadsheet

Changeable Assumptions

Additional assumptions common to all criteria may need to be changed for purposes of developing criteria applicable to a particular tribe. These assumptions include the following:

- Target excess lifetime cancer risk (ELCR): for example 10^{-6} (unitless) – found in cell C117 of the spreadsheet
- Total fish consumption rate (FCR_T): for example 0.175 kg/d – found in cell C116 of the spreadsheet

EQUATIONS FOR DEVELOPING CRITERIA

A formula for calculating water quality criteria can be generalized as the following:

$$\text{Criterion } (\mu\text{g/L}) = \frac{\text{Toxicity Value (mg/kg} \cdot \text{day)} \times \text{Body Weight (kg)} \times 1000 (\mu\text{g/L})}{\text{Total Intake (L/day and/or kg/day)}}$$

where the toxicity value depends on whether carcinogenic or non-carcinogenic effects are being considered, and the total intake depends on whether water is being consumed and whether bioconcentration or bio-accumulation factors are being used for the contaminant. These are detailed below:

Toxicity Value

The calculation of this value depends on whether carcinogenic or non-carcinogenic effects are being considered for that contaminant.

For carcinogens, the toxicity value is the unitless target excess lifetime cancer risk (e.g., 10^{-6}) divided by the cancer slope factor (CSF) for that contaminant in kg-day/mg:

$$\text{Toxicity Value for carcinogens (mg/kg} \cdot \text{day)} = \frac{\text{ELCR (unitless)}}{\text{CSF (kg} \cdot \text{day/mg)}}$$

Contaminants using the carcinogen formula are listed in the appendix to this document ([these are contaminants with a cancer slope factor in column C of the spreadsheet](#)).

For non-carcinogens, the toxicity value is the reference dose (RfD) for that contaminant in mg/kg.day) multiplied by the unitless relative source contribution (RSC) for that contaminant:

$$\text{Toxicity Value for non carcinogens} = \text{RfD(mg/kg} \cdot \text{day)} \times \text{RSC (unitless)}$$

Contaminants using the non-carcinogen formula are listed in the appendix to this ([these are contaminants with a relative source contribution listed in column D and a reference dose in column E of the spreadsheet, except for methylmercury, which is an exception described at the end of this document](#)).

Total Intake

The calculation of the total intake depends on whether water is consumed (i.e., water and organism criterion) with the fish, or not (i.e., organism only criterion). Criteria should be calculated for each contaminant for both water and organism (i.e., including the DWI of 2.4 L/d), and organism only (i.e., not including the DWI of 2.4 L/d).

The total intake also depends on whether the contaminant is associated with bio-accumulation factors (BAFs) for each trophic level, [which are listed in columns F through G of the spreadsheet](#), or a bioconcentration factor (BCF), [which is listed in column J of the spreadsheet, except for Chlorophenoxy Herbicide \(2,4-D\) and Chlorophenoxy Herbicide \(2,4,5-TP\) \[Silvex\]](#),

for which the factor is listed in column I. Equations for total intake in both cases are provided below

$$\text{Total Intake (using BAF)} = [\text{DWI (L/d) if water is consumed}] + \text{FCR}_T \times \sum_{i=2}^4 \text{BAF}_i \times \text{TL}_i$$

$$\text{Total Intake (using BCF)} = [\text{DWI (L/d) if water is consumed}] + \text{FCR}_T \times \text{BCF}$$

Exceptions

Chlorophenoxy Herbicide (2,4-D): This contaminant should use the BCF total intake calculation method, with a BCF listed as a BAF (column I instead of J).

Chlorophenoxy Herbicide (2,4,5-TP) [Silvex]: This contaminant should use the BCF total intake calculation method, with a BCF listed as a BAF (column I instead of J).

Methylmercury: This contaminant has its own formula (refer to the methylmercury criteria document).

Nickel: The RSC for this contaminant should either be changed from 0.20 to 1.0 in the spreadsheet (cell D89), or the RSC should not be included in the formula for this contaminant.

APPENDIX A – LIST OF CONTAMINANTS AND CALCULATION METHODS

The table below identifies the methodologies to be used for calculating the criteria for each contaminant. Exceptions are identified by yellow highlights.

Chemical	CAS Number	Carcinogen/ non-carcinogen toxicity value?	BAF/BCF formula?
1,1,1-Trichloroethane	71556	non-carcinogen formula	BAF
1,1,2,2-Tetrachloroethane	79345	carcinogen formula	BAF
1,1,2-Trichloroethane	79005	carcinogen formula	BAF
1,1-Dichloroethylene	75354	non-carcinogen formula	BAF
1,2,4-Trichlorobenzene	120821	carcinogen formula	BAF
1,2,4,5-Tetrachlorobenzene	95943	non-carcinogen formula	BAF
1,2-Dichlorobenzene	95501	non-carcinogen formula	BAF
1,2-Dichloroethane	107062	carcinogen formula	BAF
1,2-Dichloropropane	78875	carcinogen formula	BAF
1,2-Diphenylhydrazine	122667	carcinogen formula	BAF
1,2-Trans-Dichloroethylene	156605	non-carcinogen formula	BAF
1,3-Dichlorobenzene	541731	non-carcinogen formula	BAF
1,3-Dichloropropene	542756	carcinogen formula	BAF
1,4-Dichlorobenzene	106467	non-carcinogen formula	BAF
2,4,5-Trichlorophenol	95954	non-carcinogen formula	BAF
2,4,6-Trichlorophenol	88062	carcinogen formula	BAF
2,4-Dichlorophenol	120832	non-carcinogen formula	BAF
2,4-Dimethylphenol	105679	non-carcinogen formula	BAF
2,4-Dinitrophenol	51285	non-carcinogen formula	BCF
2,4-Dinitrotoluene	121142	carcinogen formula	BAF
2-Chloronaphthalene	91587	non-carcinogen formula	BAF
2-Chlorophenol	95578	non-carcinogen formula	BAF
2-Methyl-4,6-Dinitrophenol	534521	non-carcinogen formula	BAF
3,3'-Dichlorobenzidine	91941	carcinogen formula	BAF
3-Methyl-4-Chlorophenol	59507	non-carcinogen formula	BAF
4,4'-DDD	72548	carcinogen formula	BAF
4,4'-DDE	72559	carcinogen formula	BAF
4,4'-DDT	50293	carcinogen formula	BAF
Acenaphthene	83329	non-carcinogen formula	BCF
Acrolein	107028	non-carcinogen formula	BAF
Acrylonitrile	107131	carcinogen formula	BAF
Aldrin	309002	carcinogen formula	BAF
alpha-BHC	319846	carcinogen formula	BAF
alpha-Endosulfan	959988	non-carcinogen formula	BAF
Anthracene	120127	non-carcinogen formula	BCF
Antimony	7440360	non-carcinogen formula	BCF
Benzene- Upper CSF	71432	carcinogen formula	BAF
Benzidine	92875	carcinogen formula	BAF
Benzo(a) Anthracene	56553	carcinogen formula	BCF
Benzo(a) Pyrene	50328	carcinogen formula	BCF
Benzo(b) Fluoranthene	205992	carcinogen formula	BCF
Benzo(k) Fluoranthene	207089	carcinogen formula	BCF

Chemical	CAS Number	Carcinogen/ non-carcinogen toxicity value?	BAF/BCF formula?
beta-BHC (beta-HCH)	319857	carcinogen formula	BAF
beta-Endosulfan	33213659	non-carcinogen formula	BAF
*Bis(2-Chloro-1-Methylethyl) Ether	108601	non-carcinogen formula	BAF
Bis(2-Chloroethyl) Ether	111444	carcinogen formula	BAF
Bis(2-Ethylhexyl) Phthalate	117817	carcinogen formula	BCF
Bis(Chlormethyl) Ether	542881	carcinogen formula	BAF
Bromoform	75252	carcinogen formula	BAF
Butylbenzyl Phthalate	85687	carcinogen formula	BCF
Carbon Tetrachloride	56235	carcinogen formula	BAF
Chlordane	57749	carcinogen formula	BAF
Chlorobenzene	108907	non-carcinogen formula	BAF
Chlorodibromomethane	124481	carcinogen formula	BAF
Chloroform	67663	non-carcinogen formula	BAF
Chlorophenoxy Herbicide (2,4-D)	94757	non-carcinogen formula	BCF, but value is in column I
Chlorophenoxy Herbicide (2,4,5-TP) [Silvex]	93721	non-carcinogen formula	BCF, but value is in column I
Chrysene	218019	carcinogen formula	BCF
Cyanide	57125	non-carcinogen formula	BCF
Dibenzo(a,h) Anthracene	53703	carcinogen formula	BCF
Dichlorobromomethane	75274	carcinogen formula	BAF
Dieldrin	60571	carcinogen formula	BAF
Diethyl Phthalate	84662	non-carcinogen formula	BCF
Dimethyl Phthalate	131113	non-carcinogen formula	BCF
Di-n-Butyl Phthalate	84742	non-carcinogen formula	BCF
Dinitrophenois	25550587	non-carcinogen formula	BCF
Endosulfan Sulfate	1031078	non-carcinogen formula	BAF
Endrin	72208	non-carcinogen formula	BAF
Endrin Aldehyde	7421934	non-carcinogen formula	BAF
Ethylbenzene	100414	non-carcinogen formula	BAF
Fluoranthene	206440	non-carcinogen formula	BCF
Fluorene	86737	non-carcinogen formula	BAF
Gamma-BHC (HCH); Lindane	58899	non-carcinogen formula	BAF
Heptachlor	76448	carcinogen formula	BAF
Heptachlor Epoxide	1024573	carcinogen formula	BAF
Hexachlorobenzene	118741	carcinogen formula	BAF
Hexachlorobutadiene	87683	carcinogen formula	BAF
Hexachlorocyclohexane (HCH) - Technical	608731	carcinogen formula	BAF
Hexachlorocyclopentadiene	77474	non-carcinogen formula	BAF
Hexachloroethane	67721	carcinogen formula	BAF
Indeno(1,2,3-cd) Pyrene	193395	carcinogen formula	BCF
Isophorone	78591	carcinogen formula	BAF
Methyl Bromide	74839	non-carcinogen formula	BAF
Methylene Chloride	75092	carcinogen formula	BAF
Methylmercury	22967926	Methylmercury-specific formula	BAF

Chemical	CAS Number	Carcinogen/ non-carcinogen toxicity value?	BAF/BCF formula?
Methoxychlor	72435	non-carcinogen formula	BAF
Nickel	7440020	non-carcinogen, nickel-specific (i.e., does not use the RSC)	BCF
Nitrobenzene	98953	non-carcinogen formula	BAF
Nitrosodibutylamine	924163	carcinogen formula	BCF
Nitrosopyrrolidine	930552	carcinogen formula	BCF
N-Nitrosodimethylamine	62759	carcinogen formula	BCF
N-Nitrosodi-n-Propylamine	621647	carcinogen formula	BCF
N-Nitrosodiphenylamine	86306	carcinogen formula	BCF
Pentachlorobenzene	608935	non-carcinogen formula	BAF
Pentachlorophenol (PCP)	87865	carcinogen formula	BAF
Phenol	108952	non-carcinogen formula	BAF
Polychlorinated Biphenyls (PCBs)		carcinogen formula	BCF
Pyrene	129000	non-carcinogen formula	BCF
Selenium	7782492	non-carcinogen formula	BCF
Tetrachloroethylene	127184	carcinogen formula	BAF
Toluene	108883	non-carcinogen formula	BAF
Toxaphene	8001352	carcinogen formula	BAF
Trichloroethylene	79016	carcinogen formula	BAF
Vinyl Chloride	75014	carcinogen formula	BAF
Zinc	7440666	non-carcinogen formula	BCF